# NanoTorque
# GSW-600

## Datasheet

High performance reaction wheel for 6U, 8U and 12U nano-satellites

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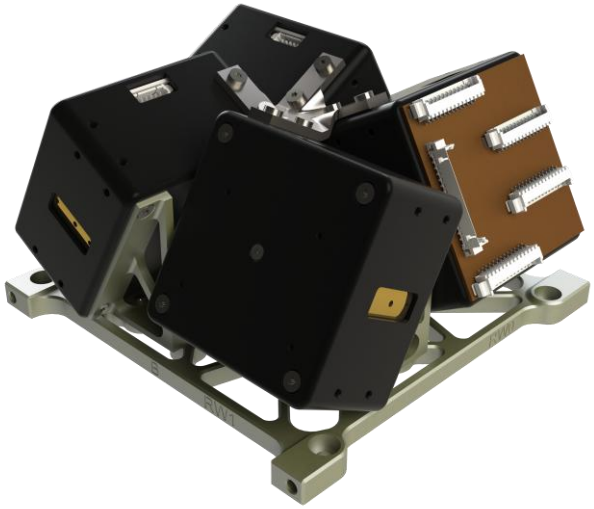
## Confidentiality Notice

# 1 Table of Contents

# 2 Overview

The GomSpace NanoTorque GSW-600 is a compact and high-performance reaction wheel designed and qualified for an equivalent of 3 years in-orbit operations.



The wheel can be purchased as either a single wheel without a mounting bracket or in a 4-wheel pyramid setup within a mounting bracket. The envelope of the reaction wheel is designed for allowing 4 wheels to be placed in a redundant setup within the envelope of a standard CubeSat.

The GSW-600 wheel is available with SPI and $I^2C$ interface[1].

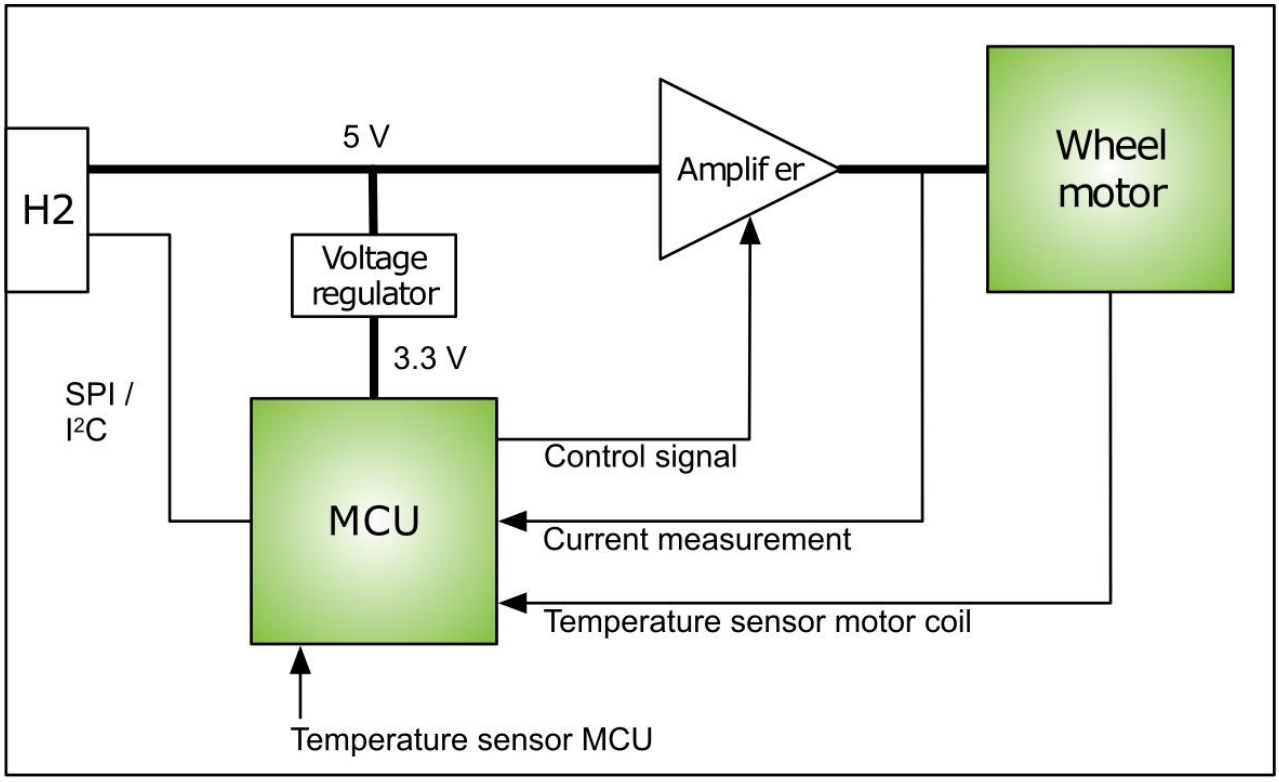
## 2.1 Highlighted Features

- 3-year design lifetime
- 2 mNm torque
- 19 mNms storage
- Long life hybrid bearings
- Precisely balanced flywheel
- Integrated electronics
- SPI and $I^2C$ interface
- Mounting from 5 sides
- IPC-A-610 Class 3 assembly

[1] External pullups are needed for $I^2C$ communication.

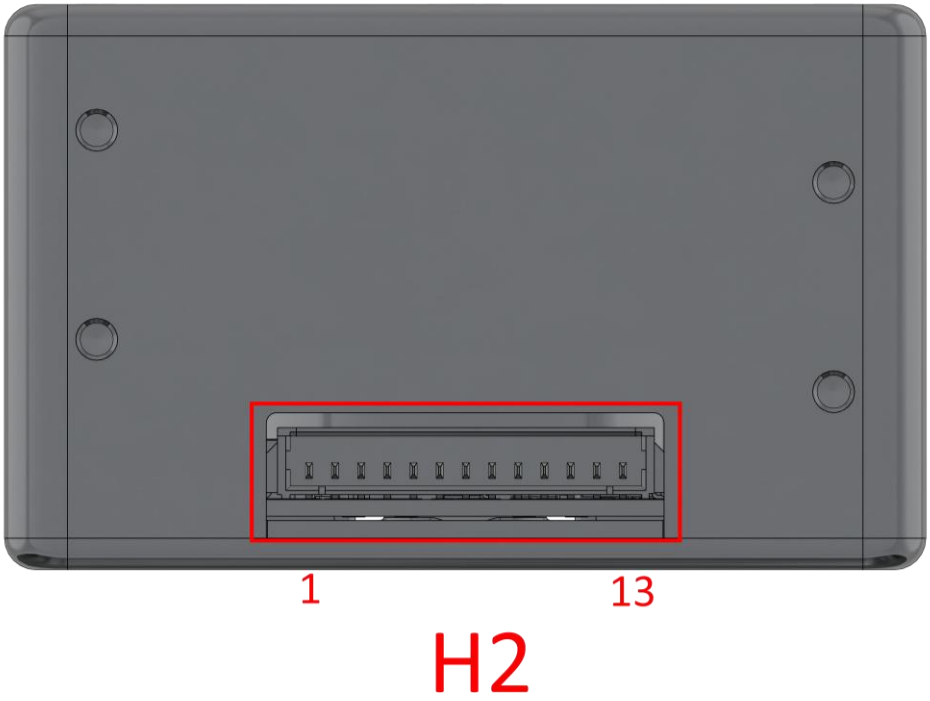
## 2.2 Block Diagram

Below is shown the data and power pathways.



# 3 Connector Pinout

## 3.1 Connector Location




## 3.2 H1 – GomSpace Debug

The 5-pin connector on the opposite side is for internal use.

## 3.3 H2 – Main Connector

The main connector provides power and communication to the GSW-600. Two communication interfaces are available: SPI and I2C. Please note that the SPI interface is the recommended interface for in-flight operation.

| Pin | Description |
|---|---|
| **1** | VCC |
| **2** | VCC |
| **3** | GND |
| **4** | GND |
| **5** | NC |
| **6** | NC |
| **7** | SPI MISO |
| **8** | SPI MOSI |
| **9** | SPI CS |
| **10** | SPI SCK |
| **11** | $I^2C$ SDA |
| **12** | $I^2C$ SCL |
| **13** | GND |

Connector type: Molex PicoBlade right angle, 053261-1371

## Absolute Maximum Ratings

Stresses above those listed under Absolute Maximum Rating may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

| Parameter | Description | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|
| **Vcc** | Maximum supply range | -0.3 | | 6.0 | V |
| **$T_{op}$** | Operational temperature range | -40 | | 80 | °C |
| **$T_{st}$** | Storage temperature range | -40 | | 85 | °C |

Note: There is no latch-up protection in the wheel itself.

# 4 Electrical and Torque Characteristics per Wheel

## 4.1 Performance

| Parameter | Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|
| **Torque** | Continuous | -1.5 | | 1.5 | mNm |
| **Minimum torque**[2] | Torque control | -0.015 | | 0.015 | mNm |
| **Speed** | Maximum | -6000 | | 6000 | rpm |
| **Speed** | At max torque | -3500 | | 3500 | rpm |
| **Momentum**[3] | At max speed | | 19 | | mNms |
| **Supply voltage** | | 4.9 | 5 | 5.1 | V |
| **Supply current** | At maximum torque | | | 500 | mA |
| **Supply current** | At 4500 rpm (zero torque) | | 130 | | mA |

## 4.2 Interface

| Parameter | Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|
| **SPI speed** | | | 100 | 130 | kbps |
| **$I^2C$ speed** | | | 100 | 400 | kHz |
| **I/O voltage** | SPI / I2C | | 3.3 | 3.4 | V |

[2] Lowest possible torque to command from standstill.
[3] See section 7.1

# 5 Physical Characteristics

## 5.1 One Wheel

| Description | Value | Unit |
|---|---|---|
| **Mass** | 180 | g |
| **Size** | 44.0 x 44.0 x 27.0 | mm |
| **Flywheel inertia** | 300 | $gcm^2$ |

## 5.2 Pyramid

Mounting bracket and 4 wheels.

| Description | Value | Unit |
|---|---|---|
| **Mass** | 940 | g |
| **Size** | 95.0 x 95.0 x 61.6 | mm |

# 6 Mounting

## 6.1 One Wheel

A single wheel can be mounted using 4 x M2 screws to an external surface using five out of the six sides. There are no mounting holes on the lid of the unit. Please refer to **Section 8.1**.

## 6.2 Pyramid Bracket Mounting

This bracket is designed for the GomSpace 6U structure but can be used with other structures.

The bracket can be mounted as part of a PC104 stack (3 mm rods) or directly on the GomSpace 6U structure (2.5 mm screws). Further holes on bottom can be used for mounting smaller units (2.5 mm screws), like a gyroscope. Please refer to **Section 8.2**.

The following torques should be used to secure the pyramid bracket to the structure:

| Tightening Cycle Count | Recommended Torque [Nm] |
|---|---|
| **1st** | 0.97 |
| **2nd** | 0.75 |
| **5th** | 0.72 |

# 7 Wheel Performance

## 7.1 Initial Operation and Nominalization

The reaction wheel requires an initial operation period prior to achieving its nominal performance characteristics. During this period, the internal bearing system undergoes a conditioning process that stabilizes lubrication distribution, contact surfaces, and thermal behavior under rotation.

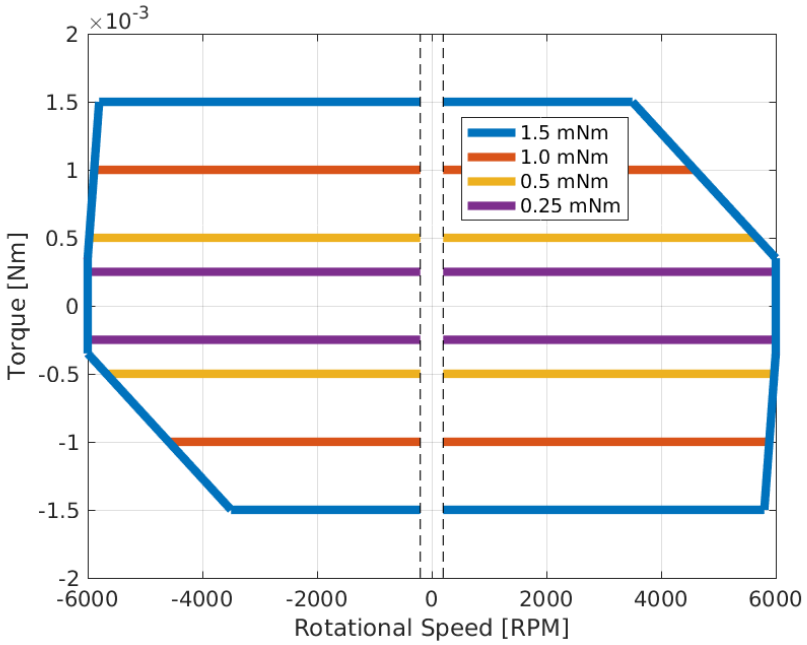
It is recommended that the wheel be operated continuously for a total duration of 48 hours, evenly divided between both rotational directions, at a representative operational speed. This process enables the mechanical interfaces and bearing elements to reach steady-state conditions, ensuring repeatable torque and momentum characteristics.

Performance parameters stated as nominal in this datasheet are valid only after completion of the initial operation and nominalization period.

While full performance cannot be guaranteed before the end of the run-in period, operating the wheels in nominal operations before the end of the run-in period does not present a risk for the health and lifetime of the wheels themselves.

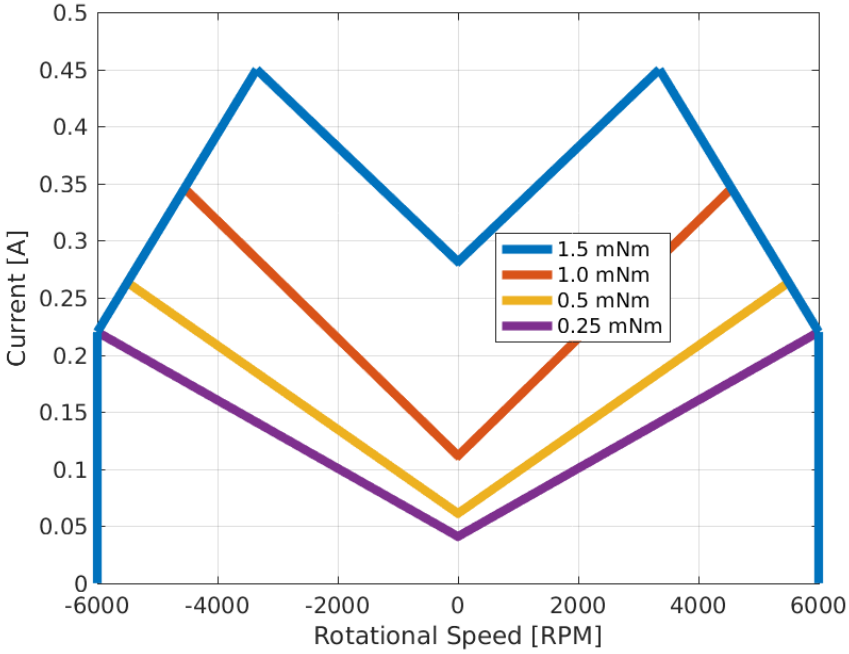
## 7.2 Torque Box

The plot shows the wheel performances for different torque levels. The dashed line indicates the dead zone which is shown on its own plot.



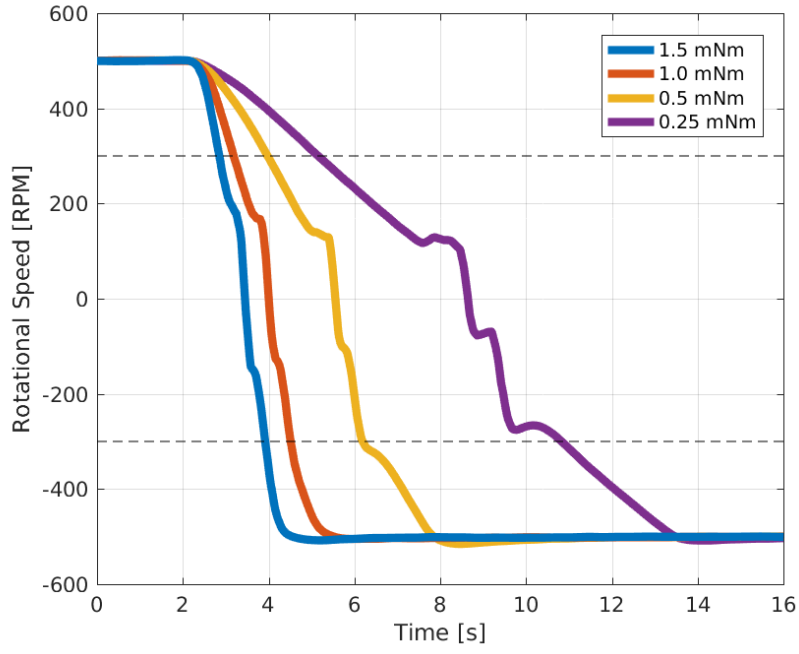
## 7.3 Current vs Speed

The plot shows the current consumption at different torque levels.




## 7.4 Dead Zone

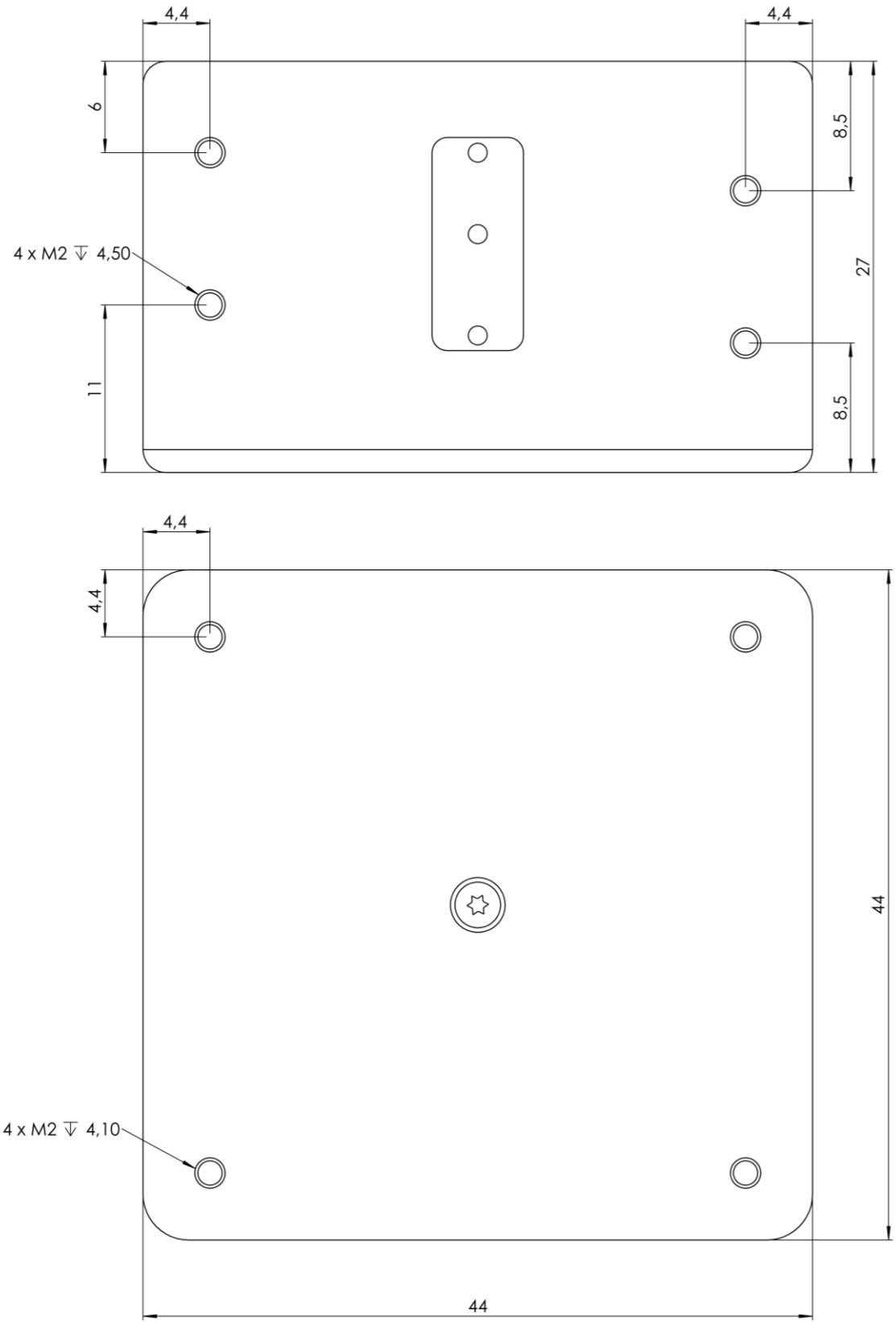
The plot below shows the behavior of the reaction wheel through the dead zone at different torque levels. The dead zone is caused by static friction and is framed by dashed lines. To ensure proper control, operating the wheel within this zone must be avoided.



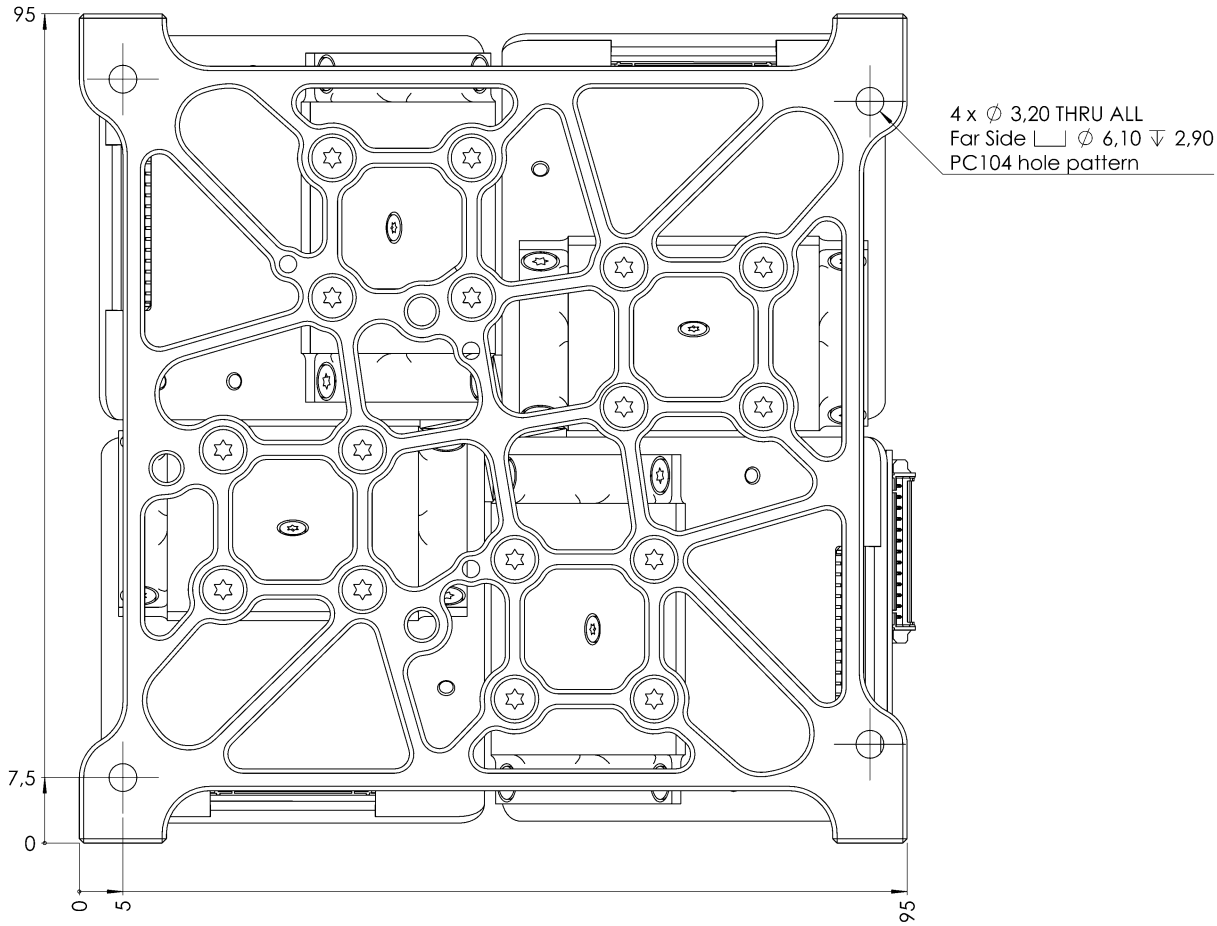
# 8 Mechanical Drawing

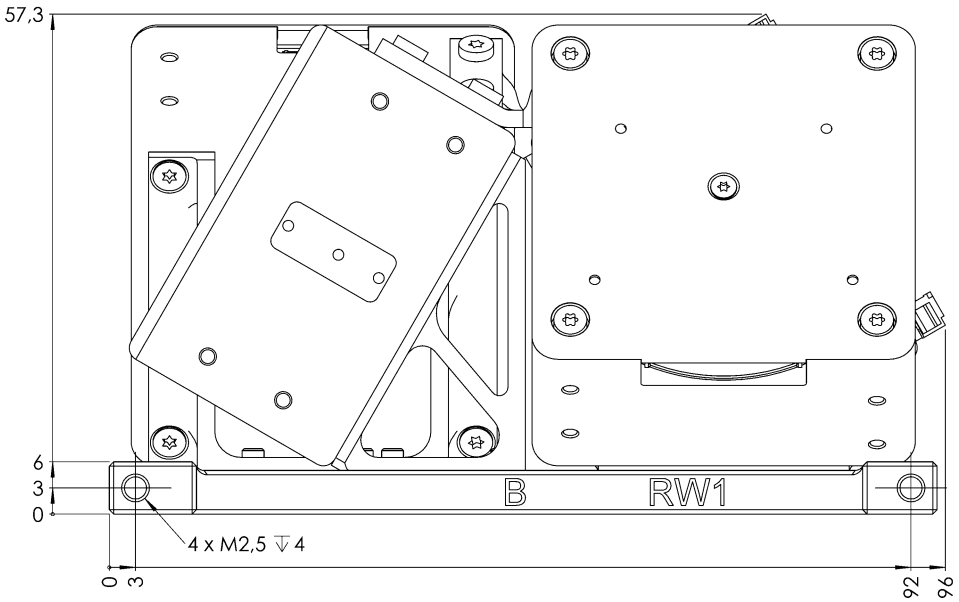
All dimensions in mm.

## 8.1 One Wheel



## 8.2 Pyramid



# 9 The GSW-600 with GomSpace AOCS Products

The GSW-600 is part of a GomSpace ADCS solution. The center unit is the NanoDock ADCS-6 or ADCS-8 PCB mounted with a NanoMind A3200 and a GPS. All peripheral units are connected to the NanoDock.

Below is shown an example with GomSpace products. View the individual datasheets for further info.

NanoDock ADCS-6 with NanoMind A3200 and GPS

NanoTorque GST-600 magnetorquer

NanoTorque GSW-600 reaction wheel

NanoStructure 6U with a Fine Sun Sensor

NanoSense M315 magnetometer

# 10 Safety and Passivation

The GSW-600 reaction wheel is designed to be inherently safe, and no command or failure can cause a mechanical breakup of it. To passivate the GSW-600 switch off the reaction wheel by removing power from it.

# 11 Disclaimer

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